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A New

THEORY OF POPULATION;

DEDUCED FROM THE

GENERAL LAW OF ANIMAL FERTILITY.

REPUBLISHED FROM THE WESTMINSTER REVIEW,
FOR APRIL, 1852.

With an Introduction,

BY R. T. TRALL, M.D.

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INTRODUCTION.

BY R. T. TRALL, M.D.

Among the many and multiplying problems of this age, none presents a more interesting field of research than that of the Theory of Population. Slightly and but superficially cultivated hitherto, this subject has appeared to us as a deep, dark wilderness, which even the wild spirit of philosophical speculation had scarcely penetrated. The world has indeed heard of the doctrines of a Malthus; a doctrine which shocks our reason, insults the moral sense, and blasphemes Deity, inasmuch as it can provide no better way of keeping the population of the earth down to the level of the means of subsistence, than by such "special providences" as war, pestilence, famine, poverty, intemperance—violence, fraud, crime and want in their broadest acceptation! It has heard, too, of the more humane and less revolting doctrine of Mr. Doubleday, who contends that "over-feeding" deadens the principle of increase, and that, therefore, the great panacea for the evil of too many people in the world is a "general plethora." With an improved system of agriculture by which the productiveness of the earth is to be vastly increased, and excessive alimentation to the extent of inducing a certain degree of physiological stupidity and procreative inability, Mr. Doubleday would have the elements of disorder, so prominent and so repugnant in the Malthusian hypothesis, removed from the order of Nature.

But neither system indicates a principle nor points to a law, which, containing within itself the elements of its own fulfillment, is to govern and regulate this matter for all time; and with nothing less than the actual demonstration of such a law will the truly philosophical mind be satisfied. The real philanthropist can never rest upon a doctrine of temporary expediency. No system which seems to remove a present difficulty, by admitting a greater one at some distant period in the future, nor, indeed

permitting the eternity of its cause, will answer. With him the weal and woe of the generations of men, thousands of centuries hence, is an object of solicitude, as well as the well-being of his co-existent fellow-beings and immediate descendants. Devoutly believing in *some* way in which all the seemingly intricate problems in human destiny are to be worked out in the good order of Divine Providence, he *must* have a theory which,

> "From seeming evil still educes good;
> And vindicates the ways of God to man."

Hence he can never adopt the notion of Malthus, which merely contemplates killing off the surplus population; nor that of Doubleday, which would introduce the retrogressive principle of bodily depravity, in order to restrain the tendency to too rapid increase. Nor need he. The following pages unfold a theory of population based on the laws of organization, sustained by all the evidences of human and comparative anatomy and physiology, and demonstrated by the whole history of all the races of mankind; while the conclusion to which it arrives is precisely that best calculated to enlist the sympathies and the prayers of every Christian—no slight presumptive evidence of its truthfulness.

Nor is the knowledge of the doctrine here disclosed only important in enabling us to contemplate more hopefully the dim, uncertain future. It is replete with practical wisdom in the present tense. The same law, immutable and eternal as its Author, which insures the accomplishment of a brighter day—a millennial period—in the future history of our race, is in operation now. It always was in full force and virtue. And our duty, our present good, our improvement, development, and happiness, as well as our chance to be represented in the future generations, are intimately connected with a recognition of this law; for it is THE LAW OF PROGRESS.

NEW THEORY OF POPULATION.

"In a very recent publication," says Dr. Whately, "I have seen mention made of a person who discovered the falsity of a certain doctrine (which, by the way, is nevertheless a true one, that of Malthus) *instinctively*. This kind of instinct, *i. e.*, the habit of forming opinions at the suggestion rather of feeling than of reason, is very common."* There can be little doubt that this remark refers to a passage in the preface to Doubleday's "True Law of Population," wherein the writer says:

"Happening many years ago, in the presence of a late relative, long since deceased, remarkable both for the sagacity and extended benevolence of his general views on philosophical subjects, to draw some of those startling, though not illogical, conclusions which seem to flow from theories then recently broached as to this subject, and much in vogue at the time, the reply was this: 'Depend upon it, my dear nephew, that you and I may safely decline to yield an implicit assent, though we may not, on the instant, be able to refute them, to views from which consequences, such as you have drawn, legitimately flow. Though I may not live to see it, nor you, a time will come when this mystery will be unvailed, and when a perhaps now mysterious, but beyond doubt, a beneficent law will be discovered, regulating this matter, in accordance with all the rest that we see of God's moral government of the world.'"

On comparing these extracts we cannot compliment Dr. Whately, either upon the fairness of his stricture or the depth of his insight. To apply the term instinctive to the conclusion thus drawn, indicates a misunderstanding of the mental process leading to it. Not a feeling, but a broad generalization is the basis on which such a conclusion rests. He who arrives at it in the manner above implied does so by comparing, in a more or

* Introductory Lectures on Political Economy, 3d edit., p. 163.

less conscious way, the alleged truth with other truths, and discovering that it is not congruous with them. By daily accumulating experience he becomes impressed with the inherent tendency of things toward good—sees going on universally a patient self-rectification. He finds that the *vis medicatrix naturæ*—or rather the process which we describe by that expression—is not limited to the cure of wounds and diseases, but pervades creation. From the lowly fungus which, under varying circumstances, assumes varing forms of organization, up to the tree that grows obliquely, if it cannot otherwise get to the light—from the highest human faculty which increases or dwindles, according to the demands made on it, down to the polype, that changes its skin into stomach and its stomach into skin when turned inside out—he everywhere sees at work an essential beneficence. Equally in the attainment of fitness for a new climate, or skill in a new occupation—in the diminution of a suppressed desire, and in the growing pleasure that attends the performance of a duty—in the gradual evanescence of grief, and in the callousness that follows long-continued privations — he perceives this remedial action. Whether he contemplates the acquirement, by each race, of a liking for the mode of life circumstances dictate—whether he regards the process by which different nations are slowly forced to produce those commodities only, that it is best for the world they should produce—or whether he looks at the repeated re-establishment among a turbulent people, of the form of government best fitted for them—he is alike struck with the self-sufficingness of things. And when, after recognizing this throughout the whole organic world, he finds that it extends to the inorganic also—when he reads that though Newton feared for the stability of the solar system, yet Laplace found that all planetary perturbations are self-neutralizing—when he thus sees that perfection exists even where so high an intelligence failed to perceive it—he is still more convinced that in all cases we shall discover harmony and completeness when we know how to look for them. Hence, if any one propounds to him a theory implying in nature an ineradicable defect, he hesitates to receive it. That the human constitution should include some condition which must ever continue to entail either physical or moral pain, is at variance with

all that a wide experience teaches him. And finding the alleged fact conflict with universal facts, he concludes that it is probably untrue. He concludes this, not instinctively, but rationally, and his argument corresponds completely with the logical form—as in all other cases I have observed a certain sequence of phenomena, I infer that there will be the same sequence in this case also. Moreover, such a belief is not only a rational, but the truly religious one. Faith in the essential beneficence of things is the highest kind of faith. And considering his position, a little more of this faith would have been by no means unbecoming in the Archbishop of Dublin.

But however right the point of view from which Mr. Doubleday, influenced by his relative, has studied the population question, it does not follow that he has solved it. We are of opinion that he has not done so. There is one fact which seems to us at once fatal to his hypothesis; namely, that it does not fulfill the very condition which it purports to fulfill: it does not disclose a self-adjusting law. The theory which Mr. Doubleday seeks to establish is, that throughout both the animal and vegetable kingdoms—

"Over-feeding checks increase; while, on the other hand, a limited or deficient nutriment stimulates and adds to it." (P. 17.)

Or, as he elsewhere says—

"Be the range of the natural power to increase in any species what it may, the *plethoric* state invariably checks it, and the *deplethoric* state invariably develops it; and this happens in the exact ratio of the intensity and completeness of such state, until each state be carried so far as to bring about the actual death of the animal or plant itself." (P. 20.)

In this arrangement, Mr. Doubleday sees a guarantee for the maintenance of species. He argues that the plethoric state of the individuals constituting any race of organisms presupposes conditions so favorable to life that the race can be in no danger; and that rapidity of multiplication becomes needless. Conversely he argues that a deplethoric state implies unfavorable conditions —implies, consequently, unusual mortality; that is—implies a necessity for increased fertility to prevent the race from dying out. And hence, applying the law to mankind, he infers that there is a state of body intermediate between the plethoric and

deplethoric, under which the rate of increase will not be greater than needful; and that a sufficient supply of good food to all, is the chief condition to the attainment of such a state.

Now, without denying that there is some such law of variation as this which Mr. Doubleday points out, we hold that it cannot alone constitute the law of population, because, as already hinted, it does not really disclose a self-rectifying arrangement. We shall quickly see this on applying it to the human race as now existing. Mr. Doubleday will admit, or rather, will assert, that on the average mankind are at present in the deplethoric state; he will argue that the undue rate of increase commonly complained of results from this; and he will infer that to produce a comparatively plethoric state in all is the only remedy. But how, under the alleged law, can a comparatively plethoric state ever be attained to? If the present production of necessaries of life is insufficient for the normal nutrition of the race, and if the resulting deplethoric state involves that the next generation will greatly exceed the present in numbers, then, for any thing that appears to the contrary, the next generation will be in a more deplethoric state still. Unless Mr. Doubleday can show that the means of subsistence will increase *more* rapidly than the unduly fertile people, he cannot prove the existence of any remedial process. Nay, indeed, he must show that his law *involves*, under such circumstances, a greater increase of food than of people. Now he neither does nor can show this; and thus the alleged law lacks that very property of self-adjustment, which he rightly regards as the test of the real law.

Mr. Doubleday has given us, not the whole truth, but only a small fraction of it. He might, *à priori*, have inferred this, had he taken a wider view of the phenomena. For just the same necessity that demands variations in the fertility of each race to balance variations in its mortality, *still more imperatively demands variations in the fertilities of different races to balance variations in their mortalities;* and whoever has duly familiarized himself with the simplicity and universality of natural agencies, can scarcely doubt that *these minor variations of fertility observable in the same species, and these great variations of fertility which distinguish different species, are determined by the same cause.*

Had Mr. Doubleday recognized this probability, he would have seen that no such special cause as that he assigns, was likely to be the true one; but that some more general cause must be looked for; and he would further have seen, that such more general cause was not to be discovered without inquiring more deeply into organic phenomena than he has done.

Some clear idea of the nature of Life itself must, indeed, form a needful preliminary. We may be sure that a search for the influences determining the maintenance and multiplication of living organisms, cannot be successfully carried out unless we understand what is the peculiar property of a living organism—what is the widest generalization of the phenomena that indicate life. By way of preparation, therefore, for the Theory of Population presently to be developed, we propose devoting a brief space to this prior question.

And here we are at once met by the difficulty, that the widest, and it would appear also, the best definition of Life, is one that includes both the organic and inorganic. Startling though the assertion will be to most, it nevertheless seems true, that, as Coleridge, or rather Schelling, points out the characteristic which, manifested in a high degree, we call Life, is a characteristic manifested only in a lower degree by so-called inanimate objects. And hard as it is to believe this, yet the discoveries of chemists, who find that the alleged distinction between organic and inorganic compounds does not hold good, and the discoveries of physiologists, who are rapidly narrowing the once broad boundary line between the two divisions, day after day serve to confirm it. Hence, in seeking for a definition that shall distinguish organic existence from inorganic existence, we must not expect to find one that will be rigidly true in all cases. For if there be not such a line of demarkation in nature, no ingenuity of ours can establish one. All we can hope for is, some expression that shall conveniently classify the two, and shall be generally, though not universally, applicable.

Employing the term, then, in its usual sense, as applicable only to organisms, Life may be defined as—*the co-ordination of actions.* The growth of a crystal, which is the highest inorganic process we are acquainted with, involves but one action—that of

accretion. The growth of a cell, which is the lowest organic process, involves two actions—accretion and disintegration—repair and waste—assimilation and oxidation. Wholly deprive a cell of oxygen, and it becomes inert—ceases to manifest vital phenomena; or, as we say, dies. Give it no matter to assimilate, and it wastes away and disappears, from continued oxidation. Evidently, then, it is in the balance of these two actions that the life consists. It is not in the assimilation alone; for the crystal assimilates: neither is it in the oxidation alone; for oxidation is common to inorganic matter: but it is in the joint maintenance of these—the *co-ordination* of them. So long as the two go on together, life continues: suspend either of them, and the result is —death.

The attribute which thus distinguishes the lowest organic from the highest inorganic bodies, similarly distinguishes the higher organisms from the lower ones. It is in the greater complexity of the co-ordination—that is, in the greater number and variety of the co-ordinated actions—that every advance in the scale of being essentially consists. And whether we regard the numerous vital processes carried on in a creature of complex structure as so many additional processes, or whether, more philosophically, we regard them as subdivisions of the two fundamental ones—oxidation and accretion—the co-ordination of them is still the life. Thus turning to what is physiologically classified as the *vegetative system*, we see that stomach, lungs, heart, liver, skin, and the rest, must work in concert. If one of them does too much or too little—that is, if the co-ordination be imperfect—the life is disturbed; and if one of them ceases to act—that is, if the co-ordination be destroyed—the life is destroyed. So likewise is it with the *animal system*, which indirectly assists in co-ordinating the actions of the viscera by supplying food and oxygen. Its component parts, the limbs, senses, and instruments of attack or defense, must perform their several offices in proper sequence; and further, must conjointly minister to the periodic demands of the viscera, that these may in turn supply blood. How completely the several attributes of animal life come within the definition, we shall best see on going through them *seriatim*.

Thus *Strength* results from the co-ordination of actions; for it

is produced by the simultaneous contraction of many muscles and many fibers of each muscle; and the strength is great in proportion to the number of these acting together; that is, in proportion to the co-ordination. *Swiftness*, also, depending partly on strength, but requiring also the rapid alternation of movements, equally comes under the expression; seeing that, other things equal, the more quickly sequent actions can be made to follow each other, the more completely are they co-ordinated. So, too, is it with *Agility;* the power of a chamois to spring with safety from crag to crag implies accurate co-ordination in the movements of many different muscles, and a due subordination of them all to the perceptions. The definition similarly includes *Instinct*, which consists in the uniform succession of certain actions or series of actions after certain sensations or groups of sensations; and that which surprises us in instinct is the accuracy with which these compound actions respond to these compound sensations; that is, the completeness of their co-ordination. Thus, likewise, is it with *Intelligence*, even in its highest manifestations. That which we call rationality is the power to combine or co-ordinate a great number and a great variety of complex actions for the achievement of a desired result. The husbandman has in the course of years, by drainage and manuring, to bring his ground into a fertile state; in the autumn he must plow, harrow, and sow, for his next year's crop; must subsequently hoe and weed, keep out cattle, and scare away birds; when harvest comes, must adapt the mode and time of getting in his produce to the weather and the labor market; he must afterward decide when, and where, and how to sell to the best advantage; and must do all this that he may get food and clothing for his family. By properly co-ordinating these various processes (each of which involve many others), by choosing right modes, right times, right quantities, right qualities, and performing his acts in right order, he attains his end. But if he have done too little of this, or too much of that, or have done one thing when he should have done another —if his proceedings have been badly co-ordinated; that is, if he have lacked intelligence, he fails.

We find, then, that *the co-ordination of actions* is a definition of Life, which includes alike its highest and its lowest manifes-

tations, and not only so, but expresses likewise the degree of Life, seeing that the Life is high in proportion as the co-ordination is great. Proceeding upward, from the simplest organic cell in which there are but two interdependent actions, on through the group in which many such cells are acting in concert, on through the higher group in which some of these cells assume mainly the respiratory and others the assimilative function—proceeding still to organisms in which these two functions are subdivided into many others, and in which some cells begin to act together as contractile fibers; next to organisms in which the visceral division of labor is carried yet further, and in which many contractile fibers act together as muscles—ascending again to creatures that combine the movements of several limbs and many bones and muscles in one action; and further, to creatures in which complex impressions are followed by the complex acts we term instinctive—and arriving finally at man, in whom not only are the separate acts complex, but who achieves his ends by combining together an immense number and variety of acts, often extending through years—we see that the progress is uniformly toward greater co-ordination of actions. Moreover, this co-ordination of actions unconsciously constitutes the essence of our common notion of life; for we shall find, on inquiry, that when we infer the death of an animal, which does not move on being touched, we infer it because we miss the usual co-ordination of a sensation and a motion; and we shall also find, that the test by which we habitually rank creatures, high or low, in the scale of vitality, is the degree of co-ordination their actions exhibit.

Further evidence that this is the true definition of life may be found in the fact, that the latest and most philosophical classification in zoology is based upon the structure of the co-ordinating apparatus, or what we commonly term the nervous system. Hunter aptly defined the function of the nerves as *internuncial*. That the separate parts of an organism may act in concert, a constant intercommunication must be kept up. This intercommunication is maintained by the nerves; and there are no actions —visceral, muscular, perceptive, or other—but what are directed and adjusted by them. When, therefore, we find that the modern division of the animal kingdom into *Acrita*, *Nematoneura*, *Ho-*

mogangliata, *Heterogangliata*, and *Vertebrata*, is a division expressive of the several forms of the internuncial or co-ordinating apparatus; and when, still more significantly, we find that these several classes rank *according to the degree in which the co-ordinating apparatus is developed*, and this, even up to man, in whom the development of it is the greatest; we have strong confirmation of the doctrine that Life and the co-ordination of actions are identical.*

There remains but to notice the objection which possibly may be raised, that the co-ordination of actions is not life, but the ability to maintain life. Lack of space forbids going into this at length. It must suffice to say, that life and the ability to maintain life will be found the same. We perpetually expend the vitality we have that we may continue our vitality. Our power to breathe a minute hence depends upon our breathing now. We must digest during this week that we may have strength to digest next. That we may get more food, we must use the force which the food we have eaten gives us. Everywhere vigorous life is the strength, activity, and sagacity whereby life is maintained; and equally in descending the scale of being, or in watching the decline of an invalid, we see that the ebbing away of life is the ebbing away of the ability to preserve life.

Ending here this preliminary dissertation, let us now proceed to our special subject.

§ 1. On contemplating its general circumstances, we perceive that any race of organisms is subject to two sets of conflicting influences. On the one hand by natural death, by enemies, by lack of food, by atmospheric changes, etc., it is constantly being destroyed. On the other hand, partly by the strength, swiftness, and sagacity of its members, and partly by their fertility, it is constantly being maintained. These conflicting sets of influences may be conveniently generalized as—the forces destructive of race, and the forces preservative of race.

§ 2. While any race continues to exist, the forces destructive

* It may be needful to remark, that by the proposed expression it is intended to define—not Life in its essence; but, Life as manifested to us—not Life as a *noumenon*; but Life as a *phenomenon*. The ultimate mystery is as great as ever; seeing that there remains unsolved the question—What *determines* the co-ordinations of actions?

of it and the forces preservative of it must perpetually tend toward equilibrium. If the forces destructive of it decrease, the race must gradually become more numerous, until, either from lack of food or from increase of enemies, the destroying forces again balance the preserving forces. If, reversely, the forces destructive of it increase, then the race must diminish until, either from its food becoming relatively more abundant, or from its enemies dying of hunger, the destroying forces sink to the level of the preserving forces. Should the destroying forces be of a kind that cannot be thus met (as great change of climate), the race, by becoming extinct, is removed out of the category. Hence this is necessarily the *law of maintenance* of all races; seeing that when they cease to conform to it they cease to be.

Now the forces preservative of race are two—ability in each member of the race to preserve itself, and ability to produce other members—power to maintain individual life, and power to propagate the species. These must vary inversely. When, from lowness of organization, the ability to contend with external dangers is small, there must be great fertility to compensate for the consequent mortality; otherwise the race must die out. When, on the contrary, high endowments give much capacity of self-preservation, there needs a correspondingly low degree of fertility. Given the dangers to be met as a constant quantity; then, as to the ability of any species to meet them must be a constant quantity too, and as this is made up of the two factors —power to maintain individual life and power to multiply—these cannot do other than vary inversely.

§ 3. To show that observed phenomena harmonize with this *à priori* principle seems scarcely needful. But, though axiomatic in its character, and therefore incapable of being rendered more certain, yet illustrations of the conformity to it which nature everywhere exhibits, will facilitate the general apprehension of it.

In the vegetable kingdom we find that the species consisting of simple cells, exhibit the highest reproductive power. The yeast fungus, which in a few hours propagates itself throughout a large mass of wort, offers a familiar example of the extreme rapidity with which these lowly organisms multiply. In the *Protococcus nivalis*, a microscopic plant which in the course of a night

reddens many square miles of snow, we have a like example; as also in the minute *Algæ*, which color the waters of stagnant pools. The sudden appearance of green films on damp, decaying surfaces, the spread of mold over stale food, and the rapid destruction of crops by mildew, afford further instance. If we ascend a step to plants of appreciable size, we still find that in proportion as the organization is low the fertility is great. Thus of the common puff-ball, which is little more than a mere aggregation of cells, Fries says, "in a single individual of *Reticularia maxima*, I have counted (calculated ?) 10,000,000 sporules." From this point upward, increase of bulk and greater complexity of structure are still accompanied by diminished reproductive power: instance the *Macrocystis pyrifera*, a gigantic sea-weed, which sometimes attains a length of 1,500 feet, of which Carpenter remarks, "This development of the nutritive surface takes place at the expense of the fructifying apparatus, which is here quite subordinate."* And when we arrive at the highly organized exogenous trees, we find that not only are they many years before beginning to bear with any abundance, but that even then they produce, at the outside, but a few thousand seeds in a twelvemonth. During its centuries of existence, an oak does not develop as many acorns as a fungus does spores in a single night.

Still more clearly is this truth illustrated throughout the animal kingdom. Though not so great as the fertility of the Protophyta, which, as Professor Henslow says, in some cases passes comprehension, the fertility of the Protozoa is yet almost beyond belief. In the polygastric animalcules spontaneous fission takes place so rapidly that "it has been calculated by Professor Ehrenberg that no fewer than 268,000,000 might be produced in a month from a single *Paramecium*;"† and even this astonishing rate of increase is far exceeded in another species, one individual of which, "only to be perceived by means of a high magnifying power, is calculated to generate 170,000,000 in four days."‡ Among the larger organisms exhibiting this lowest mode of reproduction under a modified form—that of gemmation—we see

* Prin. of Phys., 2d edit., p. 77. † Ibid., 3d edit., p. 249. ‡ Ibid., p. 124.

that, though not nearly so rapid as in the Infusoria, the rate of multiplication is still extremely high. This fact is well illustrated by the polypes; and in the apparent suddenness with which whole districts are blighted by the Aphis (multiplying by inter nal gemmation), we have a familiar instance of the startling re sults which the parthenogenetic process can achieve. Where reproduction becomes occasional instead of continuous, as it does among higher creatures, the fertility equally bears an inverse ratio to the development. "The queen ant of the African *Termites* lays 80,000 eggs in twenty-four hours; and the common hair worm (*Gordius*) as many as 8,000,000 in less than one day."* Among the *Vertebrata*, the lowest are still the most prolific. "It has been calculated," says Carpenter, "that above a million of eggs are produced at once by a single codfish."† In the strong and sagacious shark comparatively few are found. Still less fertile are the higher reptiles. And among the Mammalia, beginning with small Rodents, which quickly reach maturity, produce large litters, and several litters in the year; advancing step by step to the higher mammals, some of which are long in attaining the reproductive age, others of which produce but one litter in a year, others but one young one at a time, others who unite these peculiarities; and ending with the elephant and man, the least prolific of all, we find that throughout this class, as throughout the rest, ability to multiply decreases as ability to maintain individual life increases.

§ 4. The *à priori* principle thus exemplified has an obverse of a like axiomatic character. We have seen that for the continuance of any race of organisms it is needful that the power of self-preservation and the power of reproduction should vary inversely. We shall now see that, quite irrespective of such an end to be subserved, these powers could not do otherwise than vary inversely. In the nature of things, species can subsist only by conforming to this law; and equally in the nature of things they cannot help conforming to it.

Reproduction, under all its forms, may be described as the separation of portions of a parent plant or animal for the purpose

* Agassiz and Gould, p. 274.

† Prin. of Phys., 3d edit., p. 964

of forming other plants or animals. Whether it be by spontaneous fission, by gemmation, or by gemmules; whether the detached products be bulbels, spores, or seeds, ovisacs, ova or spermatozoa; or however the process of multiplication be modified, it essentially consists in the throwing off of parts of adult organisms for the purpose of making new organisms. On the other hand, self-preservation is fundamentally a maintenance of the organism in undiminished bulk. Among the lowest forms of life, aggregation of tissue is the only mode in which the self-preserving power is shown. Even in the highest, sustaining one body in its integrity is that in which self-preservation most truly consists—is the end which the widest intelligence is indirectly made to subserve. While, on the one side, it cannot be denied that the increase of tissue constituting growth is self-preservation both in essence and in result; neither can it, on the other side, be denied that a diminution of tissue, either from injury, disease, or old age, is in both essence and result the reverse.

Hence the maintenance of the individual and the propagation of the race, being respectively aggregative and separative, *necessarily* vary inversely. Every generative product is a deduction from the parental life; and, as already pointed out, to diminish life is to diminish the ability to preserve life. The portion thrown off is organized matter; vital force has been expended in the organization of it, and in the assimilation of its component elements; which vital force, had no such portion been made and thrown off, *would have been available for the preservation of the parent.*

Neither of these forces, therefore, can increase, save at the expense of the other. The one draws in and incorporates new material; the other throws off material previously incorporated. The one adds to; the other takes from. Using a convenient expression for describing the facts (though one that must not be construed into an hypothesis), we may say that the force which builds up and repairs the individual is an attractive force, while that which throws off germs is a repulsive force. But whatever may turn out to be the true nature of the two processes, it is clear that they are mutually destructive; or, stating the proposition in its briefest form—Individuation and Reproduction are antagonistic.

Again, illustrating the abstract by reference to the concrete, let us now trace throughout the organic world the various phases of this antagonism.

§ 5. All the lowest animal and vegetable forms—*Protozoa* and *Protophyta*—consist essentially of a single cell containing fluid, and having usually a solid nucleus. This is true of the Infusoria, the simplest Entozoa, and the microscopic Algæ und Fungi. The organisms so constituted uniformly multiply by spontaneous fission. The nucleus, originally spherical, becomes elongated, then constricted across its smallest diameter, and ultimately separates, when "its divisions," says Professor Owen, describing the process in the Infusoria, "seem to repel each other to positions equidistant from each other, and from the pole or end of the body to which they are nearest. The influence of these distinct centers of assimilation is to divert the flow of the plasmatic fluid from a common course through the body of the polygastrian to two special courses about those centers. So much of the primary developmental process is renewed, as leads to the insulation of the sphere of the influence of each assimilative center from that of the other by the progressive formation of a double party-wall of integument, attended by progressive separation of one party-wall from the other, and by concomitant constriction of the body of the polygastrian, until the vibratile action of the superficial cilia of each separating moiety severs the narrow neck of union, and they become two distinct individuals."* Similar in its general view is Dr. Carpenter's description of the multiplication of vegetable cells, which he says divide, "in virtue, it may be surmised, of a sort of mutual repulsion between the two halves of the endochrome (colored cell-contents) which leads to their spontaneous separation."† Under a modified form of this process the cell-contents, instead of undergoing bisection, divide into numerous parts, each of which ultimately becomes a separate individual. In some of the Algæ "a whole brood of young cells may thus be at once generated in the cavity of the parent-cell, which subsequently bursts and sets them free."‡ The *Achlya prolifera* multiplies after this fashion. Among the Fungi, too,

* Parthenogenesis, p. 8. † Prin. of Phys., p. 92. ‡ Ibid., p. 93.

the same mode of increase is exemplified by the *Protococcus nivalis*. And, "it would appear that certain Infusoria, especially the *Kolpodinæ*, propagate by the breaking-up of their own mass into reproductive particles."*

Now in this fissiparous mode of multiplication, which "is amazingly productive, and indeed surpasses in fertility any other with which we are acquainted,"† we see most clearly the antagonism between individuation and reproduction. We see that the reproductive process involves destruction of the individual; for in becoming two the parent fungus or polygastrian must be held to lose its own proper existence; and when it breaks up into a numerous progeny, does so still more completely. Moreover, this rapid mode of multiplication not only destroys the individuals in whom it takes place, but also involves that their individualities, while they continue, shall be of the lowest kind. For assume a protozoon to be growing by imbibition at a given rate, and it follows that the oftener it divides the smaller must be the size it attains to; that is, the smaller the development of its individuality. And a further manifestation of the same truth is seen in the fact, that the more frequent the spontaneous fission the shorter the existence of each individual. So that alike by preventing any thing beyond a microscopic bulk being attained, by preventing the continuance of this in its integrity beyond a few hours, and by being fatal when it occurs, this most active mode of reproduction shows the extremest antagonism to individual life.

§ 6. Whether or not we regard reproduction as resulting from a repulsive force (and, as seen above, both Owen and Carpenter lean to some such view), and whether or not we consider the formation of the individual as due to the reverse of this—an attractive force—we cannot, on studying the phenomena, help admitting that two opposite activities thus generalized are at work; we cannot help admitting that the aggregative and separative tendencies do in each case determine the respective developments of the individual and the race. On ascending one

* Prin. of Phys., p. 917.

† A General Outline of the Animal Kingdom. By Prof. T. R. Jones, F.G.S., p. 61.

degree in the scale of organic life, we shall find this truth clearly exemplified.

For if these single-celled organisms which multiply so rapidly be supposed to lose some of their separative tendency, what must be the result? They now not only divide frequently, but the divided portions fly apart. How, then, will a diminution of this separative tendency first show itself? May we not expect that it will show itself in the divided portions *not* flying apart, but remaining near each other, and forming a group? This we find in nature to be the first step in advance. The lowest compound organisms are "*simple aggregations of vesicles without any definite arrangement, sometimes united, but capable of existing separately.*"* In these cases, "every component cell of the aggregate mass that springs from a single germ, being capable of existing independently of the rest, may be regarded as a distinct individual."† The several stages of this aggregation are very clearly seen in both the animal and vegetable kingdoms. In the *Hæmatococcus binalis*, the plant producing the reddish slime seen on damp surfaces, not only does each of the cells retain its original sphericity, but each is separated from its neighbor by a wide interval filled with mucus; so that it is only as being diffused through a mass of mucus common to them all, that these cells can be held to constitute one individual. We find, too, that "the component cells, even in the highest Algæ, are generally separated from each other by a large quantity of mucilaginous intercellular substance."‡ And, again, the tissue, of the simpler Lichens, "in consequence of the very slight adhesion of its component cells, is said to be pulverulent."§ Similarly the Protozoa, by their feeble union, constitute the organisms next above them. Among the Polygastrica there are many cases "in which the individuals produced by fission or gemmation do not become completely detached from each other."‖ The *Ophrydium*, for instance, "exists under the form of a motionless jelly-like mass . . . made up of millions of distinct and similar individuals imbedded in a gelatinous connecting substance;"¶ and again, the

* Carpenter. † Prin. of Phys., p. 873 ‡ Ibid., p. 203. § Ibid., p. 209.
‖ Ibid., p. 249. ¶ Ibid., p. 249.

Uvella, or "grape monad," consists of a cluster "which strongly resembles a transparent mulberry rolling itself across the field of view by the ciliary action of its component individuals."* The parenchyma of the Sponge, too, is made up of cells "each of which has the character of a distinct animalcule, having a certain power of spontaneous motion, obtaining and assimilating its own food, and altogether living *by* and *for* itself;" and so small is the cohesion of these individual cells, that the tissue they constitute "drains away when the mass is removed from the water, like white of egg."†

Of course in proportion as the aggregative tendency leading to the formation of these groups of monads is strong, we may expect that, other things equal, the groups will be large. Proceeding upward from the yeast fungus, whose cells hold together in groups of four, five, and six,‡ there must be found in each species of these composite organisms a size of group determined by the strength of the aggregative tendency in that species. Hence we may expect that, when this limit is passed, the group no longer remains united, but divides. Such we find to be the fact. These groups of cells undergo the same process that the cells themselves do. They increase up to a certain point, and then multiply either by simple spontaneous fission or by that modification of it called gemmation. The *Volvox globator*, which is made up of a number of monads associated together in the form of a hollow sphere, develops within itself a number of smaller spheres similarly constituted; and after these, swimming freely in its interior, have reached a certain size, the parent group of animalcules bursts, and sets the interior groups free. And here we may observe how this compound individuality of the Volvox is destroyed in the act of reproduction, as the simple individuality of the monad is. Again, in the higher forms of grouped cells, where something like organization begins to show itself, the aggregations are not only larger, but the separative process, now carried on by the method of gemmation, no longer wholly destroys the individual. And in fact, this gemmation may be regarded as the form which spontaneous fission must assume in ceasing to be fatal; seeing that

* Prin. of Phys., p. 250. † Ibid., p. 256. ‡ Ibid., p. 212.

gemmation essentially consists in the separation, not into halves, but into a larger part and a smaller part; the larger part continuing to represent the original individual. Thus in the common *Hydra*, or fresh-water polype, "little bud-like processes are developed from the external surface, which are soon observed to resemble the parent in character, possessing a digestive sac, mouth, and tentacula; for a long time, however, their cavity is connected with that of the parent; but at last the communication is cut off, and the young polype quits its attachment, and goes in quest of its own maintenance."*

§ 7. Progress from these forms of organization to still higher forms is similarly characterized by increase of the aggregative tendency or diminution of the separative, and similarly exhibits the necessary antagonism between the development of the individual and the increase of the race. That process of grouping which constitutes the first step toward the production of complex organisms, we shall now find repeated in the formation of series of groups. Just as a diminution of the separative tendency is shown in the aggregation of divided monads, so is a further diminution of it shown in the aggregation of the divided groups of monads. The first instance that occurs is afforded by the compound polypes. "Some of the simpler forms of the composite *Hydroida*," says Carpenter, "may be likened to a *Hydra*, whose gemmæ, instead of becoming detached, remain permanently connected with the parent; and as these in their turn may develop gemmæ from their own bodies, a structure of more or less arborescent character may be produced."† A similar species of combination is observable among the *Bryozoa*, and the compound *Tunicata*. Every degree of union may be found among these associated organisms; from the one extreme in which the individuals can exist as well apart as together, to the other extreme in which the individuals are lost in the general mass. While each *Bryozoon* is tolerably independent of its neighbor, "in the compound *Hydroida*, the lives of the polypes are subordinate to that of the polypdom."‡ Of the *Salpidæ* and *Pyrosomidæ*, Carpenter says:—"Although closely attached to one another, these

* Prin. of Phys., p. 266. † Ibid., 267. ‡ Ibid., p. 276.

associated animals are capable of being separated by a smart shock applied to the sides of the vessel in which they are swimming. . . . In other species, however, the separate animals are imbedded in a gelatinous mass," and in one kind "there is an absolute union between the vascular systems of the different individuals."*

In the same manner that with a given aggregative tendency there is a limit to the size of groups, so is there a similarly-determined limit to the size of series of groups; and that spontaneous fission which we have seen in cells and groups of cells we here find repeated. In the lower *Annelida*, for example, "after the number of segments in the body has been greatly multiplied by gemmation, a separation of those of the posterior portion begins to take place; a constriction forms itself about the beginning of the posterior third of the body, in front of which the alimentary canal undergoes a dilatation, while on the segment behind it a proboscis and eyes are developed, so as to form the head of the young animal which is to be budded off; and in due time, by the narrowing of the constriction a complete separation is effected."† Not unfrequently in the *Nais* this process is repeated in the young one before it becomes independent of the parent. The higher *Annelida* are distinguished by the greater number of segments held in continuity; an obvious result of comparatively infrequent fission. In the class *Myriapoda*, which stands next above, "there is no known instance of multiplication by fission."‡ Yet even here the law may be traced both in the number and structure of the segments. The length of the body is still increased after birth "by gemmation from (or partial fission of) the penultimate segment." The lower members of the class are distinguished from the higher by the greater extent to which this gemmation is carried. Moreover, the growing aggregative tendency is seen in the fact, that each segment of the Julus "is formed by the coalescence of two original segments,"§ while in the *Scolopendridæ*, which are the highest of this class, "the head, according to Mr. Newport, is com

* Prin of Phys, 2d edit., p. 115. † Ibid., p. 954. ‡ Ibid., p. 958.
§ Ibid., p. 688

posed of eight segments, which are often consolidated into one piece;"* both of which phenomena may be understood as arrests of the process of fission, which, if allowed to go a little further, would have produced distinct segments; and, if allowed to go further still, would have separated these segments into groups.

§ 8. Remarking, first, how gradually this mode of multiplication disappears—how there are some creatures that spontaneously divide or not, according to circumstances; other that divide when in danger (the several parts being capable of growing into complete individuals); others which, though not self-dividing, can live on in each half if artificially divided; and others in which only one of the divided halves can live—how, again, in the Crustaceans the power is limited to the reproduction of lost limbs; how there are certain reptiles that can re-supply a lost tail, but only imperfectly; and how among the higher *Vertebrata* the ability to repair small injuries is all that remains—remarking thus much, let us now, by way of preparation for what is to follow, consider the significance of the foregoing facts, taken in connection with the definition of Life awhile since given.

This spontaneous fission, which we have seen to be, in all cases, more or less destructive of individual life, is simply a cessation in the co-ordination of actions. From the single cell, the halves of whose nucleus, instead of continuing to act together, begin to repel each other, fly apart, establish dictinct centers of assimilation, and finally cause the cell to divide; up to the Annelidan, whose string of segments separates, after reaching a certain length; we everywhere see the phenomenon to be fundamentally this. The tendency to separate is the tendency not to act together, probably arising from inability to act together any longer; and the process of separation is the process of ceasing to act together. How truly non-co-ordination is the essence of the matter, will be seen on observing that fission takes place more or less rapidly, according as the co-ordinating apparatus is less or more developed. Thus, "the capability of spontaneous division is one of the most distinctive attributes of the acrite type of

* Prin. of Phys., 2d edit., p. 958.

structure;"* the acrite type of structure being that in which the neurine or nervous matter is supposed to be diffused through the tissues in a molecular state, and in which, therefore, there exists no distinct nervous or co-ordinating system. From this point upward the gradual disappearance of spontaneous fission is clearly related to the gradual appearance of nerves and ganglia—a fact well exemplified by the several grades of *Annelida* and *Myriapoda*. And when we remember that in the embryotic development of these classes, the nervous system does not make its appearance until after the rest of the organism has made great progress, we may even suspect that that coalescence of segments characteristic of the *Myriapoda*, exhibits the co-ordinating power of the rapidly-growing nervous system overtaking and arresting the separative tendency; and doing this most where it (the nervous system) is most developed, namely, in the head.

And here let us remark, in passing, how, from this point of view, we still more clearly discern the antagonism of individuation and reproduction. We before saw that the propagation of the race is at the expense of the individual: in the above facts we may contemplate the obverse of this—may see that the formation of the individual is at the expense of the race. This combination of parts that are tending to separate and become distinct beings—this union of many incipient minor individualities into one large individuality—is an arrest of reproduction—a diminution in the number produced. Either these units may part and lead independent lives, or they may remain together and have their actions co-ordinated. Either they may, by their diffusion, form a small, simple, and prolific race, or, by their aggregation, a large, complex, and infertile one. But manifestly the aggregation involves the infertility; and the fertility involves the smallness.

§ 9. The ability to multiply by spontaneous fission, and the ability to maintain individual life, are opposed in yet another mode. It is not in respect of size only, but still more in respect of structure, that the antagonism exists.

Higher organisms are distinguished from lower ones partly by bulk, and partly by complexity. This complexity essentially

* A General Outline of the Animal Kingdom. By Professor T. R. Jones, p. 61.

consists in the mutual dependence of numerous different organs, each subserving the lives of the rest, and each living by the help of the rest. Instead of being made up of many like parts, performing like functions, as the Crinoid, the Star-fish, or the Millipede, a vertebrate animal is made up of many unlike parts, performing unlike functions. From that initial form of a compound organism, in which a number of minor individuals are simply grouped together, we may, more or less distinctly, trace not only the increasing closeness of their union, and the gradual disappearance of their individualities in that of the mass, but the gradual assumption by them of special duties. And this "physiological division of labor," as it has been termed, has the same effect as the division of labor among men. As the preservation of a number of persons is better secured when, uniting in a society, they severally undertake different kinds of work, than when they are separate, and each performs for himself every kind of work; so the preservation of a congeries of parts, which, combining into one organism, respectively assume nutrition, respiration, circulation, locomotion, as separate functions, is better secured than when those parts are independent, and each fulfills for itself all these functions.

But the condition under which this increased ability to maintain life becomes possible is, that the parts shall cease to separate. If they are perpetually separating, it is clear that they cannot assume mutually subservient duties. And it is further clear that the more the tendency to separate diminishes, that is, the larger the groups that remain connected, *the more minutely and perfectly can that subdivision of functions which we call organization be carried out.*

Thus we see that in its most active form the ability to multiply is antagonistic to the ability to maintain individual life, not only as preventing increase of bulk, but also as preventing organization—not only as preventing homogeneous co-ordination, but as preventing heterogeneous co-ordination.

§ 10. To establish the unbroken continuity of this law of fertility, it will be needful, before tracing its results among the higher animals, to explain in what manner spontaneous fission is now understood, and what the cessation of it essentially means.

Originally naturalists supposed that creatures which multiply by self-division, under any of its several forms, continue so to multiply perpetually. In many cases, however, it has latterly been shown that they do not do this; and it is now becoming a received opinion that they do not, and cannot, do this, in any case. A fertilized germ appears here, as among higher organisms, to be the point of departure; and that constant formation of new tissue implied in the production of a great number of individuals by fission, seems gradually to exhaust the germinal capacity in the same way that the constant formation of new tissue, during the development of a single mammal, exhausts it. The phenomena classified by Steenstrup as "Alternate Generation," and since generalized by Professor Owen in his work "On Parthenogenesis," illustrate this. The egg of a *Medusa* (jelly-fish) develops into a polypoid animal, called the *Strobila*. This *Strobila* lives as the polype does, and, like it, multiplies rapidly by gemmation. After a great number of individuals have been thus produced, and when, as we must suppose, the germinal capacity is approaching exhaustion, each *Strobila* begins to exhibit a series of constrictions, giving it some resemblance to a rouleau of coin or a pile of saucers. These constrictions deepen; the segments gradually develop tentacula; the terminal segment finally separates itself, and swims away in the form of a young *Medusa;* the other segments, in succession, do the same; and from the eggs which these *Medusæ* produce, other like series of polypoid animals, multiplying by gemmation, originate. In the compound Polypes, in the *Tunicata*, in the *Trematoda*, and in the Aphis, we have repeated, under various modifications, the same phenomenon.

Understanding, then, this lowest and most rapid mode of multiplication to consist essentially in the production of a great number of individuals from a single germ—perceiving, further, that diminished activity of this mode of multiplication consists essentially in the aggregation of the germ-product into larger masses—and seeing, lastly, that the disappearance of this mode of multiplication consists essentially in the aggregation of the germ-product into *one* mass—we shall be in a position to comprehend, among the higher animals, that new aspect of the law,

under which increased individuation still involves diminished reproduction. Progressing from those lowest forms of life in which a single ovum originates countless organisms, through the successive stages in which the number of organisms so originated becomes smaller and smaller; and finally arriving at a stage in which one ovum produces but one organism; we have now, in our further ascent, to observe the modified mode in which this same necessary antagonism between the ability to multiply, and the ability to preserve individual life, is exhibited.

§ 11. Throughout both the animal and vegetable kingdoms, generation is effected "by the union of the contents of a 'sperm-cell' with those of a 'germ-cell;' the latter being that from within which the embryo is evolved, while the former supplies some material or influence necessary to its evolution."* Among the lowest vegetable organisms, as in the *Desmideæ*, the *Diatomaceæ*, and other families of the inferior *Algæ*, these cells do not appreciably differ; and the application to them of the terms "sperm-cell" and "germ-cell" is hypothetical. From this point upward, however, distinctions become visible. As we advance to higher and higher types of structure, marked differences arise in the character of these cells, in the organs evolving them, and in the position of these organs, which are finally located in separate sexes. Doubtless a separation in the *functions* of "sperm-cell" and "germ-cell" has simultaneously arisen. That change from homogeneity of function to heterogeneity of function which essentially constitutes progress in organization may be assumed to take place here also; and, indeed, it is probable that the distinction gradually established between these cells, in origin and appearance, is merely significant of and consequent upon, the distinction that has arisen between them in constitution and office. Let us now inquire in what this distinction consists.

If the foundation of every new organism be laid by the combination of two elements, we may reasonably suspect that these two elements are typical of some two fundamental divisions of which the new organism is to consist. As nothing in nature is without meaning and purpose, we may be sure that the univer-

* Prin. of Phys., p. 907.

sality of this binary origin, signifies the universality of a binary structure. The simplest and broadest division of which an organism is capable must be that signified. What, then, must this division be?

The proposed definition of organic life supplies an answer. If organic life be the co-ordination of actions, then an organism may be primarily divided into parts whose actions are co-ordinated, and parts which co-ordinate them—organs which are made to work in concert, and the apparatus which makes them so work—or, in other words, the assimilative, vascular, excretory, and muscular systems on the one hand, and the nervous system on the other. The justness of this classification will become further apparent, when it is remembered that by the nervous system alone is the individuality established By it all parts are made one in purpose, instead of separate; by it the organism is rendered a conscious whole—is enabled to recognize its own extent and limits; and by it are all injuries notified, repairs directed, and the general conservation secured. The more the nervous system is developed, the more reciprocally subservient do the components of the body become—the less can they bear separating. And that which thus individuates many parts into one whole, must be considered as more broadly distinguished from the parts individuated, than any of these parts from each other. Further evidence in support of this position may be drawn from the fact, that as we ascend in the scale of animal life, that is, as the co-ordination of actions becomes greater, we find the co-ordinating or nervous system becoming more and more definitely separated from the rest; and in the vertebrate or highest type of structure we find the division above insisted on distinctly marked. The co-ordinating parts and the parts co-ordinated are placed on opposite sides of the vertebral column. With the exception of a few ganglia, the whole of the nervous masses are contained within the neural arches of the vertebræ; while all the viscera and limbs are contained within, or appended to, the hæmal arches—the terms neural and hæmal having, indeed, been chosen to express this fundamental division.

If, then, there be truth in the assumption that the two elements, which, by their union, give origin to a new organism, typify the

two essential constituents of such new organism, we must infer that the sperm-cell and germ-cell respectively consist of co-ordinating matter and matter to be co-ordinated — neurine and nutriment. That apparent identity of sperm-cell and germ-cell seen in the lowest forms of life may thus be understood as significant of the fact that no extended co-ordination of actions exists in the generative product—each cell being a separate individual; and the dissimilarity seen in higher organic types as expressive of, and consequent upon, the increasing degree of co-ordination exhibited."*

That the sperm-cell and germ-cell are thus contrasted in nature and function may further be suspected on considering the distinctive characteristics of the sexes. Of the two elements they respectively contribute to the formation of a fertile germ, it may be reasonably supposed that each furnishes that which it possesses in greatest abundance and can best spare. Well, in the greater size of the nervous centers in the male, as well as in the fact that during famines men succumb sooner than women, we see that in the male the co-ordinating system is relatively predominant. From the same evidence, as well as from the greater abundance of the cellular and adipose tissues in women, we may infer that the nutritive system predominates in the female.† Here, then, is additional support for the hypothesis that the sperm-cell, which is supplied by the male, contains co-ordinating matter, and the germ-cell, which is supplied by the female, contains matter to be co-ordinated.

The same inference may, again, be drawn from a general view of the maternal function. For if, as we see, it is the office of the mother to afford milk to the infant, and during a previous period to afford blood to the fœtus, it becomes probable that during a yet earlier stage it is still the function to supply nutriment, though

* Should it be objected that in the higher plants the sperm-cell and germ-cell differ, though no distinct co-ordinating system exists, it is replied that there *is* co-ordination of actions, though of a feeble kind, and that there must be some agency by which this is carried on.

† It is a significant fact that among the dioecious invertebrata, where the nutritive system greatly exceeds the other systems in development, the female is commonly the largest, and often greatly so. In some of the Rotifera the male has no nutritive system at all. See *Prin. of Phys.*, p. 954.

in another form. Indeed, when, ascending gradually the scale of animal life, we perceive that this supplying of milk, and before that of blood, is simply a continuation of the previous process, we may be sure that, with Nature's usual consistency, this process is essentially one from the beginning.

Quite in harmony with this hypothesis concerning the respective natures of the sperm-cell and germ-cell is a remark of Carpenter's on the same point:

"Looking," he says, "to the very equal mode in which the characters of the two parents are mingled in *hybrid* offspring, and to the certainty that the *material* conditions which determine the development of the germ are almost exclusively female, it would seem probable that the *dynamical* conditions are, in great part, furnished by the male."*

§ 12. Could nothing but the foregoing indirect evidence be adduced in proof of the proposition that the spermatozoon is essentially a neural element, and the ovum essentially a hæmal element, we should scarcely claim for it any thing more than plausibility. On finding, however, that this indirect evidence is merely introductory to evidence of a quite direct nature, its significance will become apparent. Adding to their weight taken separately the force of their mutual confirmation, these two series of proofs will be seen to give the hypothesis a high degree of probability. The direct evidence now to be considered is of several kinds.

On referring to the description of the process of multiplication in monads, quoted some pages back (§ 5), from Professor Owen, the reader will perceive that it is by the pellucid nucleus that the growth and reproduction of these single-celled creatures are regulated. The nucleus controls the circulation of the plasmatic fluid; the fission of the nucleus is the first step toward the formation of another cell; each half of the divided nucleus establishes round itself an independent current; and, apparently, it is by the repulsion of the nuclei that the separation into two individuals is finally effected. All which facts, when generalized, imply that the nucleus is the governing or *co-ordinating* part. Now, Professor Owen subsequently points out that the matter of

* Prin. of Phys., p. 908.

the sperm-cell performs in the fertilized germ-cell just this same function which the nucleus performs in a single-celled animal. We find the absorption by a germ-cell of the contents of a sperm-cell "followed by the appearance of a pellucid nucleus in the center of the opaque and altered germ-cell; we further see its successive fissions governed by the preliminary division of the pellucid center;" and, led by these and other facts, Professor Owen thinks that "one cannot reasonably suppose that the nature and properties of the nucleus of the impregnated germ-cell and that of the monad can be different."* And hence he further infers that "the nucleus of the monad is of a nature similar to, if not identical with," the matter of the spermatozoon. But we have seen that in the monad the nucleus is the co-ordinating part; and hence to say that the sperm-cell is, in nature, identical with it, is to say that the sperm-cell consists of co-ordinating matter.

Chemical analysis affords further evidence, though, from the imperfect data at present obtained, less conclusive evidence than could be wished. Partly from the white and gray nervous substances having been analyzed together instead of separately, and partly from the difficulty of isolating the efficient contents of the sperm-cells, a satisfactory comparison cannot be made. Nevertheless, possessing in common, as they do, one element, by which they are specially characterized, the analysis, as far as it goes, supports our argument. The following table, made up from data given in the *Cyclopædia of Anatomy and Physiology*, *Art.* Nervous System, gives the proportion of this element in the brain in different conditions, and shows how important is its presence:

	In Infants.	In Youth.	In Adults.	In OldMen.	In Idiots.
Solid constituents in a hundred parts of brain	17·21	25·74	27·49	26·15	29·07
Of these solid constituents the phosphorus amounts to	0·8	1·65	1·80	1·00	0·85
Which gives a per centage of phosphorus in the solid constituents of	4·65	6·41	6·54	3·82	2·92

* Parthenogenesis, pp. 66, 67.

This connection between the quantity of phosphorus present, and the degree of mental power exhibited, is sufficiently significant; and the fact that in the same individual the varying degrees of cerebral activity are indicated by the varying quantities of alkaline phosphates excreted by the kidneys,* still more clearly shows the essentialness of phosphorus as a constituent of nervous matter. Respecting the constitution of sperm-cells chemists do not altogether agree. One thing, however, is certain—that they contain unoxidized phosphorus; and also a fatty acid, that is not improbably similar to the fatty acid contained in neurine.† In fact, there would seem to be present the constituents of that oleophosphoric acid which forms so distinctive an element of the brain. That a large quantity of binoxide of protein is also present, may be ascribed to the fact that a great part of the sperm-cell consists merely of the protective membrane and its locomotive appendage; the really efficient portion being but the central contents.‡

Evidence of a more conclusive nature—evidence, too, which will show in what direction our argument tends—is seen in the marked antagonism of the nervous and generative systems. Thus, the fact that intense mental application, involving great waste of the nervous tissues, and a corresponding consumption of nervous matter for their repair, is accompanied by a cessation in the production of sperm-cells, gives strong support to the hypothesis that the sperm-cells consist essentially of neurine. And this becomes yet clearer on finding that the converse fact is true—that undue production of sperm-cells involve cerebral inactivity. The first result of a morbid excess in this direction is headache, which may be taken to indicate that the brain is out of repair; this is followed by stupidity; should the disorder continue, imbecility supervenes, ending occasionally in insanity.

* Lectures on Animal Chemistry. By Dr. Bence Jones. *Medical Times*, Sept. 13th, 1851. See also *Prin. of Phys.*, p. 171.

† Cyclopædia of Anatomy and Physiology, vol. iv., p. 506.

‡ From a remark of Drs. Wagner and Leuckart this chemical evidence seems to have already suggested the idea that the sperm-cell becomes "metamorphosed into the central parts of the nervous system." But though they reject this assumption, and though the experiments of Mr. Newport clearly render it untenable, yet none of the facts latterly brought to light conflict with the hypothesis that the sperm-cell contains unorganized co-ordinating matter.

That the sperm-cell is co-ordinating matter, and the germ-cell matter to be co-ordinated, is, therefore, an hypothesis not only having much *à priori* probability, but one supported by numer ous facts.

§ 13. This hypothesis alike explains, and is confirmed by the truth, that throughout the vertebrate tribes the degree of fertility varies inversely as the development of the nervous system.

The necessary antagonism of Individuation and Reproduction does indeed show itself among the higher animals, in some degree in the manner hitherto traced; namely, as determining the total bulk. Though the parts now thrown off, being no longer segments or gemmæ, are not obvious diminutions of the parent, yet they must be really such. Under the form of internal fission, the separative tendency is as much opposed to the aggregative tendency as ever; and, *other things equal*, the greater or less development of the individual depends upon the less or greater production of new individuals or germs of new individuals. As in groups of cells, and series of groups of cells, we saw that there was in each species a limit, passing which the germ product would not remain together; so in each species of higher animal there is a limit, passing which, the process of cell-multiplication results in the throwing off of cells, instead of resulting in the formation of more tissue. Hence, taking an average view, we see why the smaller animals so soon arrive at a reproductive age, and produce large and frequent broods; and why, conversely, increased size is accompanied by retarded and diminished fertility.

But, as above implied, it is not so much to the bulk of the body as a whole, as to the bulk of the nervous system, that fertility stands related among the higher animals. Probably, indeed, it stands thus related in all cases; the difference simply arising from the fact, that whereas in the lower organisms, where the nervous system is not concentrated, its bulk varies as the bulk of the body, in the higher organisms it does not do so. Be this as it may, however, we see clearly that, among the vertebrata, the bodily development is not the determining circumstance. In a fish, a reptile, a bird, and a mammal of the same

weight, there is nothing like equality of fecundity. Cattle and horses, arriving as they do so soon at a reproductive age, are much more prolific than the human race, at the same time that they are much larger. And while, again, the difference in size between the elephant and man is far greater, their respective powers of multiplication are less unlike. Looking in these cases at the nervous systems, however, we find no such discrepancy. On learning that the average ratio of the brain to the body is—in fishes, 1 to 5,668; in reptiles, 1 to 1,321; in birds, 1 to 212; and in mammals, 1 to 186;* their different degrees of fecundity are accounted for. Though an ox will outweigh half a dozen men, yet its brain and spinal cord are far less than those of one man; and though in bodily development the elephant so immensely exceeds the human being, yet the elephant's cerebro-spinal system is only thrice the size attained by that of civilized men.† Unfortunately it is impossible to trace throughout the animal kingdom this inverse relationship between the nervous and reproductive systems with any accuracy. Partly from the fact that, in each case, the degree of fertility depends on three variable elements—the age at which reproduction begins, the number produced at a birth, and the frequency of the births; partly from the fact that, in respect to most animals, these data are not satisfactorily attainable, and that when they are attainable they are vitiated by the influence of domesticity; and partly from the fact that no precise measurement of the respective nervous systems has been made, we are unable to draw any but general and somewhat vague comparisons. These, however, so far as they go, are in our favor. Ascending from beings of the acrite nerveless type, which are the most prolific of all, through the various

* Quain's Elements of Anatomy, p. 672.

† The maximum weight of the horse's brain is 1 lb. 7 oz.; the human brain weighs 3 lbs., and occasionally as much as 4 lbs.; the brain of a whale, 75 feet long, weighed 5 lbs. 5 oz.; and the elephant's brain reaches from 8 lbs. to 10 lbs. Of the whale's fertility we know nothing; but the elephant's quite agrees with the hypothesis. The elephant does not attain its full size until it is thirty years old, from which we may infer that it arrives at a reproductive age later than man does; its period of gestation is two years, and it produces one at a birth. Evidently, therefore, it is much less prolific than man. See Müller's *Physiology* (Baly's translation), p. 815, and Quain's *Elements of Anatomy*, p. 671.

invertebrate sub-kingdoms, among which spontaneous fission disappears as the nervous system becomes developed; passing again to the least nervous and most fertile of the vertebrate series—Fishes, of which, too, the comparatively large-brained cartilaginous kinds multiply much less rapidly than the others; progressing through the more highly endowed and less prolific Reptiles to the Mammalia, among which the Rodents, with their unconvoluted brains, are noted for their fecundity; and ending with man and the elephant, the least fertile and largest-brained of all—there seems to be throughout a constant relationship between these attributes.

And indeed, on turning back to our *à priori* principle, no other relationship appears possible. We found it to be the necessary law of maintenance of races, that the ability to maintain individual life and the ability to multiply vary inversely. But the ability to maintain individual life *is in all cases measured by the development of the nervous system.* If it be in good visceral organization that the power of self-preservation is shown, this implies some corresponding nervous apparatus to secure sufficient food. If it be in strength, there must be a provision of nerves and nervous centers answering to the number and size of the muscles. If it be in swiftness and agility, a proportionate development of the cerebellum is pre-supposed. If it be in intelligence, this varies with the size of the cerebrum. As in all cases co-ordination of actions constitutes the life, or, what is the same thing, the ability to maintain life; and as throughout the animal kingdom this co-ordination, under all its forms, is effected by nervous agents of some kind or other; and as each of these nervous agents performs but one function, it follows that in proportion to the number of the actions co-ordinated must be the number of nervous agents. Hence the nervous system becomes the universal measure of the degree of co-ordination of actions; that is, of the life, or ability to maintain life. And if the nervous system varies directly as the ability to maintain life, it *must* vary inversely as the ability to multiply.*

* That the size of the nervous system is the measure of the ability to maintain life, is a proposition that must, however, be taken with some qualifications. The ratio between

And here, assuming the constitution of the sperm-cell above inferred to be the true one, we see how the obverse *à priora* principle is fulfilled. Where, as among the lowest organisms, bulk is expressive of life, the antagonism of individuation and re-production was broadly exhibited in the fact that the making of two or more new individuals was the *un*making of the original individual. And now, among the higher organisms, where bulk is no longer the measure of life, we see that this antagonism is between the neural elements thrown off, and that internal neural mass whose bulk *is* the measure of life. The production of co-ordinating cells must be at the expense of the co-ordinating apparatus; and the aggregation of the co-ordinating apparatus must be at the expense of co-ordinating cells. How the antagonism affects the female economy is not so clear. Possibly the provision required to be made for supplying nervous as well as other nutriment to the embryo, involves an arrest in the development of the nervous system; and if so, probably this arrest takes place early in proportion as the number of the coming offspring makes the required provision great: or rather, to put the facts in their right sequence, an early arrest renders the production of a numerous offspring possible.

§ 14. The law which we have thus traced throughout the animal kingdom, and which must alike determine the different fertilities of species, and the variations of fertility in the same species, we have now to consider in its application to mankind.

From the fact that the human race is in a state of transition, we may suspect that the existing ratio between its ability to multiply, and its ability to maintain life, is not a constant ratio. From the fact that its fertility is at present in excess of what is needful, we may infer that any change in the ratio will probably

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the amounts of gray and white matter present in each case is probably a circumstance of moment. Moreover, the temperature of the blood may have a modifying influence; seeing that small nervous centers exposed to rapid oxidation will be equivalent to larger ones more slowly oxidized. Indeed, we see among mankind, that though, in the main, size of brain determines mental power, yet temperament exercises some control. There is reason to think, too, that certain kinds of nervous action involve greater consumption of nervous tissue than others; and this will somewhat complicate the comparisons. Nevertheless, these admissions do not affect the generalization as a whole, but merely prepare us to meet with minor irregularities.

be toward a diminution of fertility. And from the fact that, on the whole, civilization increases the ability to maintain life, we may perceive that there is at work some influence by which such diminution is necessitated. Before inquiring for this influence, let us consider what directions an increase of ability to maintain life may take—what scope there is for an increase. In some further development of the co-ordinating system, that is, in some greater co-ordination of actions, the increase must of course consist. But there are several kinds of co-ordination; and it will be well to ask of what kind or kinds increase is most requisite, and therefore most likely. For, doubtless, in conformity with the general law of adaptation, increase will take place only where it is demanded.

Will it be in strength? Probably not. Though from prehistoric remains, we may gather that the race has become more bulky, yet the cause of this change seems now diminishing. Mechanical appliances are fast supplanting muscular force, and will most likely continue to do so until they leave to be done by manual labor only as much as is needful for the healthy maintenance of the body at its then attained size.

Will it be in swiftness or agility? Probably not. In the savage these form important elements of the ability to maintain life; but in the civilized man they subserve that end in quite a minor degree, and there seems no circumstance likely to necessitate an increase of them.

Will it be in mechanical skill, that is, in the better co-ordination of complex movements? Most likely in some degree. Awkwardness is continually entailing injuries and loss of life. Moreover, the complicated tools developed by civilization are constantly requiring greater delicacy of manipulation. Already the cerebellum, which is the nervous center directing compound motions, is larger in man than in any other creature except the elephant; and the daily-increasing variety and complexity of the processes he has to perform, and the appliances he has to use, may be expected to cause a further growth of it.

Will it be in intelligence? Largely, no doubt. There is ample room for progress in this direction, and ample demand for it. Our lives are universally shortened by our ignorance. In attain-

ing complete knowledge of our own nature, and of the nature of surrounding things—in ascertaining the conditions of existence to which we must conform, and in discovering means of conforming to them under all variations of seasons and circumstances—we have abundant scope for intellectual culture, and urgent need for intellectual development.

Will it be in morality, that is, in greater power of self-regulation? Largely, also; perhaps most largely. Normal conduct, or in other words, conduct conducive to the maintenance of perfect and long-continued life, is usually come short of more from defect of will than of knowledge. To the due co-ordination of those complex actions which constitute human life in its civilized form, there goes not only the prerequisite—recognition of the proper course; but the further prerequisite—a due impulse to pursue that course. And on calling to mind our daily failures to fulfill often-repeated resolutions, we shall perceive that lack of the needful desire, rather than lack of the needful insight, is the chief cause of faulty action. A further endowment of those feelings which civilization is developing in us—sentiments responding to the requirements of the social state—emotive faculties that find their gratifications in the duties devolving on us—must be acquired before the crimes, excesses, diseases, improvidences, dishonesties, and cruelties, that now so greatly diminish the duration of life, can cease.

But whether greater co-ordination of actions take place in any or in all of these directions, and in whatever degree or proportions, it is clear that, if it take place at all, it must be at the expense of fertility. Regarded from the abstract point of view, increased ability to maintain life in this case, as in all others, necessarily involves decreased ability to multiply. Or, regarded in the concrete, that further development of the co-ordinating system, which any advance pre-supposes, implies further decrease in the production of co-ordinating cells.

§ 15. That an enlargement of the nervous centers is going on in mankind, is an ascertained fact. Not alone from a general survey of human progress—not alone from the greater power of self-preservation, shown by civilized races, are we left to infer such enlargement; it is proved by actual measurement. The

mean capacities of the crania in the leading divisions of the species have been found to be—

In the	Australian	75 cubit inches.
"	African	82 "
"	Malayan	86 "
"	Englishman	96* "

showing an increase in the course of the advance from the savage state to our present phase of civilization, amounting to nearly 30 per cent. on the original size. That this increase will be continuous, might be reasonably assumed; and to infer a future decrease of fertility would be tolerably safe, were no further evidence forthcoming. But it may be shown why a greater development of the nervous system *must* take place, and why, consequently, there *must* be a diminution of the present excess of fertility; and further, it may be shown that the sole agency needed to work out this change is—*the excess of fertility itself.*

For, as we all know, this excess of fertility entails a constant pressure of population upon the means of subsistence; and, as long as it exists, must continue to do this. Looking only at the present and the immediate future, it is unquestionably true that if unchecked, the rate of increase of people would exceed the rate of increase of food. It is clear that the wants of their redundant numbers constitute the only stimulus mankind have to a greater production of the necessaries of life; for, were not the demand beyond the supply, there would be no motive to increase the supply. Moreover, this excess of demand over supply, and this pressure of population, of which it is the index, cannot be eluded. Though by the emigration that takes place when the pressure arrives at a certain intensity, a partial and temporary relief may be obtained, yet, as by this process all habitable countries must gradually become peopled, it follows, that in the end the pressure, whatever it may then be, must be borne in full.

But this inevitable redundancy of numbers—this constant increase of people beyond the means of subsistence—involving as it does an increasing stimulus to better the modes of producing food and other necessaries—involves also an increasing demand

* Lecture by Professor Owen, before the Zoological Society, Nov. 11th, 1851.

for skill, intelligence, and self-control—involves, therefore, a constant exercise of these, that is—involves a gradual growth of them. Every improvement is at once the product of a higher form of humanity, and demands that higher form of humanity to carry it into practice. The application of science to the arts is simply the bringing to bear greater intelligence for satisfying our wants; and implies continued increase of that intelligence. To get more produce from the acre, the farmer must study chemistry—must adopt new mechanical appliances—and must, by the multiplication of tools and processes, cultivate both his own powers and the powers of his laborers. To meet the requirements of the market, the manufacturer is perpetually improving his old machines, and inventing new ones; and by the premium of high wages incites artisans to acquire greater skill. The daily widening ramifications of commerce entail upon the merchant a need for more knowledge and more complex calculations; while the lessening profits of the ship-owner force him to employ greater science in building, to get captains of higher intelligence, and better crews. In all cases, increase of numbers is the efficient cause. Were it not for the competition this entails, more thought would not daily be brought to bear upon the business of life; greater activity of mind would not be called for; and development of mental power would not take place. Difficulty in getting a living is alike the incentive to a higher education of children, and to a more intense and long-continued application in adults. In the mother it induces foresight, economy, and skillful housekeeping; in the father, laborious days and constant self-denial. Nothing but necessity could make men submit to this discipline, and nothing but this discipline could produce a continued progression. The contrast between a Pacific Islander, all whose wants are supplied by Nature, and an Englishman, who, generation after generation, has had to bring to the satisfaction of his wants ever-increasing knowledge and skill, illustrates at once the need for, and the effects of, such discipline. And this being admitted, it cannot be denied that a further continuance of such discipline, possibly under a yet more intense form, must produce a further progress in the same direction—a further enlargement of the nervous centers, and a further decline of fertility.

And here it must be remarked, that the effect of pressure of population, in increasing the ability to maintain life, and decreasing the ability to multiply, is not a uniform effect, but an average one. In this case, as in many others, Nature secures each step in advance by a succession of trials, which are perpetually repeated, and cannot fail to be repeated, until success is achieved. All mankind in turn subject themselves more or less to the discipline described; they either may or may not advance under it; but, in the nature of things, only those who *do* advance under it eventually survive. For, necessarily, families and races whom this increasing difficulty of getting a living which excess of fertility entails, does not stimulate to improvements in production —that is, to greater mental activity—are on the high road to extinction; and must ultimately be supplanted by those whom the pressure does so stimulate. This truth we have recently seen exemplified in Ireland. And here, indeed, without further illustration, it will be seen that premature death, under all its forms, and from all its causes, cannot fail to work in the same direction. For as those prematurely carried off must, in the average of cases, be those in whom the power of self-preservation is the least, it unavoidably follows, that those left behind to continue the race are those in whom the power of self-preservation is the greatest—are the select of their generation. So that, whether the dangers to existence be of the kind produced by excess of fertility, or of any other kind, it is clear, that by the ceaseless exercise of the faculties needed to contend with them, and by the death of all men who fail to contend with them successfully, there is insured a constant progress toward a higher degree of skill, intelligence, and self-regulation—a better co-ordination of actions—a more complete life.

§ 16. There now remains but to inquire toward what limit this progress tends. Evidently, so long as the fertility of the race is more than sufficient to balance the diminution by deaths, population must continue to increase; so long as population continues to increase, there must be pressure on the means of subsistence; and so long as there is pressure on the means of subsistence, further mental development must go on, and further diminution of fertility must result. Hence, the change can never

cease until the rate of multiplication is just equal to the rate of mortality; that is, can never cease until, on the average, each pair brings to maturity but two children. Probably this involves that each pair will rarely produce more than two offspring; seeing that with the greatly increased ability to preserve life, which the hypothesis presupposes, the amount of infant and juvenile mortality must become very small. Be this as it may, however, it is manifest that, in the end, pressure of population and its accompanying evils will entirely disappear; and will leave a state of things which will require from each individual no more than a normal and pleasurable activity. That this last inference is a legitimate corollary will become obvious on a little consideration. For, a cessation in the decrease of fertility implies a cessation in the development of the nervous system; and this implies that the nervous system has become fully equal to all that is demanded of it—has not to do more than is natural to it. But that exercise of faculties which does not exceed what is natural constitutes gratification. Consequently, in the end, the obtainment of subsistence will require just that kind and that amount of action needful to perfect health and happiness.

Thus do we see how simple are the means by which the greatest and most complex results are worked out. From the point of view now reached, it becomes plain that the necessary antagonism of individuation and reproduction not only fulfills with precision the *à priori* law of maintenance of race, from the monad up to man, but insures the final attainment of the highest form of this maintenance—a form in which the amount of life shall be the greatest possible, and the births and deaths the fewest possible. In the nature of things the antagonism could not fail to work out the results we see it working out. The gradual diminution and ultimate disappearance of the original excess of fertility could take place only through the process of civilization; and, at the same time, the excess of fertility has itself rendered the process of civilization inevitable. From the beginning, pressure of population has been the proximate cause of progress. It produced the original diffusion of the race. It compelled men to abandon predatory habits and take to agriculture. It led to the clearing of the earth's surface. It forced men into the social

state; made social organization inevitable; and has developed the social sentiments. It has stimulated to progressive improvements in production, and to increased skill and intelligence. It is daily pressing us into closer contact and more mutually dependent relationships. And after having caused, as it ultimately must, the due peopling of the globe, and the bringing of all its habitable parts into the highest state of culture—after having brought all processes for the satisfaction of human wants to the greatest perfection—after having, at the same time, developed the intellect into complete competency for its work, and the feelings into complete fitness for social life—after having done all this, we see that the pressure of population, as it gradually finishes its work, must gradually bring itself to an end.

THE END.

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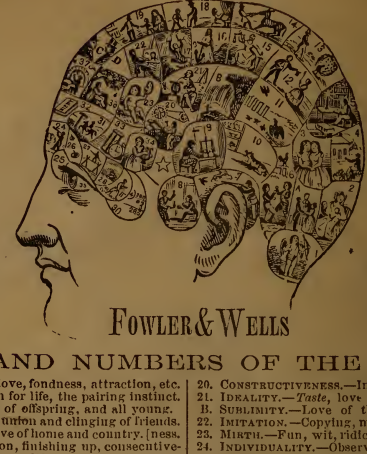

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NAMES AND NUMBERS OF THE ORGANS.

1. AMATIVENESS.—Sexual love, fondness, attraction, etc.
A. CONJUGAL LOVE.—Union for life, the pairing instinct.
2. PARENTAL LOVE.—Care of offspring, and all young.
3. FRIENDSHIP.—Sociality, union and clinging of friends.
4. INHABITATIVENESS.—Love of home and country. [ness.
5. CONTINUITY.—Application, finishing up, consecutive-
E. VITATIVENESS.—Clinging to life, repelling disease.
6. COMBATIVENESS.—Defense, resolution, force, courage.
7. DESTRUCTIVENESS—Extermination, severity, hardness.
8. ALIMENTIVENESS.—Appetite, relish, feeding, greed.
9. ACQUISITIVENESS.—Frugality, saving, industry, thrift.
10. SECRETIVENESS.—Self-control, policy, tact, artifice.
11. CAUTIOUSNESS.—Guardedness, safety, provision, fear.
12. APPROBATIVENESS.—Love of character, name, praise.
13. SELF-ESTEEM.—Self-respect, dignity, self-reliance, Inde-
14. FIRMNESS.—Stability, perseverance, decision. [pendence
15. CONSCIENTIOUSNESS.—Sense of right, justice, duty, etc.
16. HOPE.—Expectation, anticipation, trust in the future.
17. SPIRITUALITY.—Intuition, prescience, prophecy, faith.
18. VENERATION—Worship, adoration, devotion, deference.
19. BENEVOLENCE.—Sympathy, kindness, goodness.
20. CONSTRUCTIVENESS.—Ingenuity, *manual* skill. [ment.
21. IDEALITY.—*Taste*, love of beauty, poetry, and refine-
B. SUBLIMITY.—Love of the grand, vast, endless, and
22. IMITATION.—Copying, mimicking, doing like. [infinite.
23. MIRTH.—Fun, wit, ridicule facetiousness, joking.
24. INDIVIDUALITY.—Observation, desire to *see* and know.
25. FORM.—Memory of *shape* looks, persons, and things.
26. SIZE.—Measurement of quantity, distance, etc., *by eye.*
27. WEIGHT.—Control of motion, balancing, hurling, etc.
28. COLOR.—Discernment and love of colors, tints, hues, etc.
29. ORDER.—*Method*, system, going by *rule*, keeping things
30. CALCULATION—Men al arithmetic, reckoning. [in place.
31. LOCALITY.—Memory of places, position, etc. [falls, etc.
32. EVENTUALITY.—Memory of facts, events, history, de-
33. TIME.—Telling *when*, time of day, dates, how long, etc.
34. TUNE.—Love of music, singing and playing *by ear.*
35. LANGUAGE.—*Expression* by words, acts, tones, looks, etc.
36. CASUALITY.—*Planning*, thinking, reasoning, adapting.
37. COMPARISON.—Analysis, inferring, discrimination, etc.
C. HUMAN NATURE.—Perception of character, motives, etc.
D. SUAVITY.—*Pleasantness*, blandness, persuasiveness.

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